Elastomeric Selectively Permeable Membranes For Chemical and Biological Protective Clothing

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JUL 2003	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Elastomeric Selectively Permeable MembranesFor Chemical and Biological Protective Clothing	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Soldier, and Biological Chemical Command (SBCCOM) Soldier Systems Center (SSC) Natick, MA 01760-5019**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001523., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**12**	

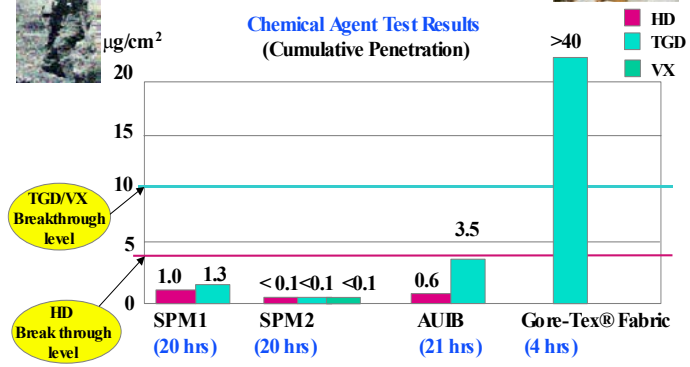
•ADVANCED LIGHTWEIGHT CB PROTECTION PROGRAM (DTO CB-06a-12-D) WAS SUCCESSFULLY COMPLETED IN FY00, WHERE SPM UNIFORMS WERE PREFERRED OVER CURRENT CHEMICAL PROTECTIVE GARMENTS

Accomplishments:

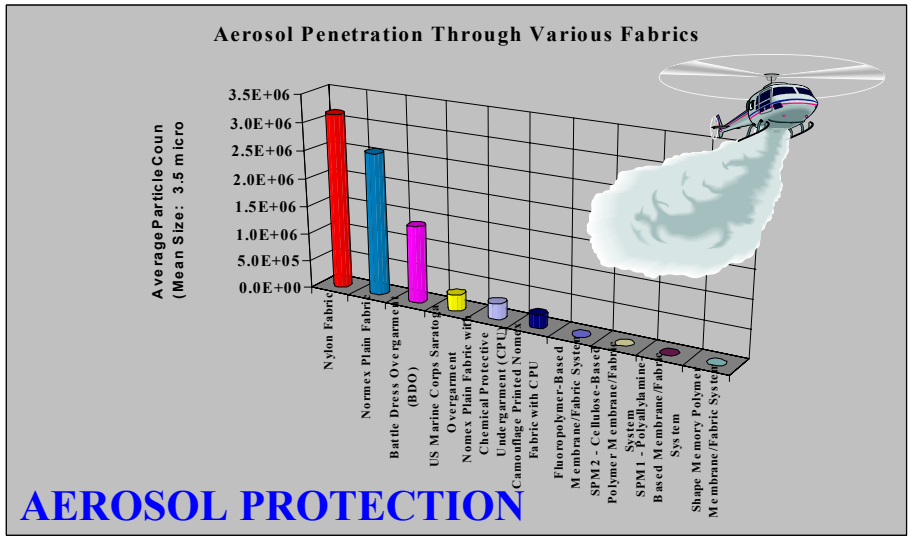
- Developed and demonstrated SPM garments that are 50% lighter weight than any fielded garment with equivalent or better protection.
- Integrated novel closure systems and demonstrated their effectiveness via MIST @ERDEC, @DPG
- Conducted field-assessments for field durability and perception of comfort of prototype CB duty uniforms.
  - •Ft. Lewis, WA with the Maneuver Support Battle Labs (MSBL)
  - •Pohakuloa and Kaneohe Bases, Hawaii with the Marine Corps and Army MSBL
- Transition to JPACE, JIG, SOF, and JCBE

Impacts:

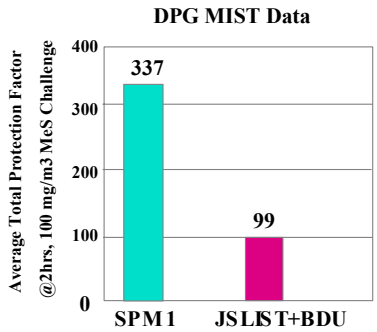
- Reduced thermal stress
- Reduced logistics burden
- Increased CB agent protection
- Eliminated dependency on charcoal adsorbent



SPM1: Polyallylamine-Based SPM2: Cellulose-Based
AUIB: Aircrew Uniform Integrated Battlefield (Carbon loaded foam + Gore-Tex fabric)



AEROSOL PROTECTION



JSLIST: Joint Service Lightweight Integrated Suit Technology

SPM1: Polyallylamine-Based

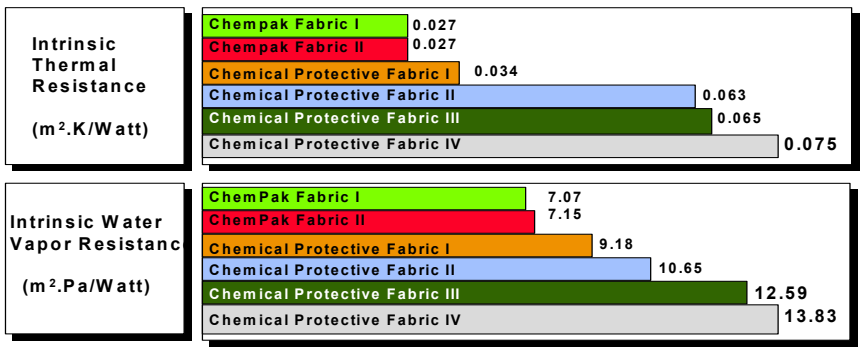
BDU: Battle Dress Duty Uniform

DPG: Dugway Proving Ground, Utah

MIST: Man-In-Simulant System Vapor Test

VAPOR PROTECTION

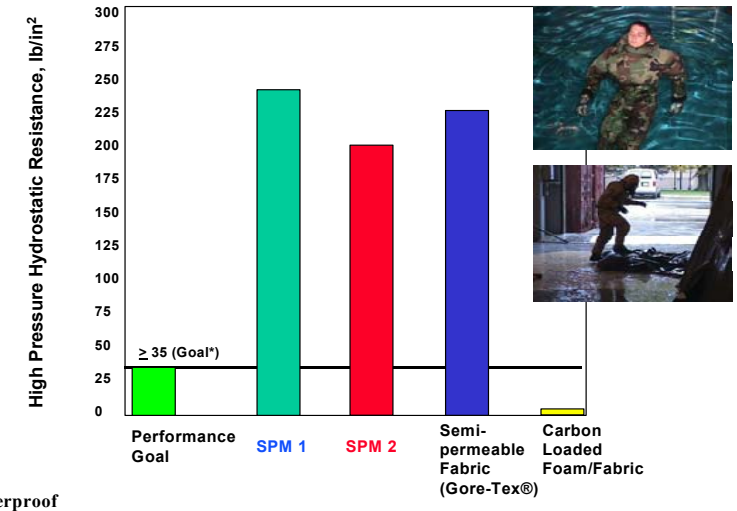
EVAPORATIVE COOLING POTENTIALS of SPMs vs. VARIOUS CB FABRIC SYSTEMS



Chemical Protective Fabrics I-IV: Various CB Fabric Systems

REDUCED HEAT STRESS

High Pressure Hydrostatic Resistance



*Being Waterproof

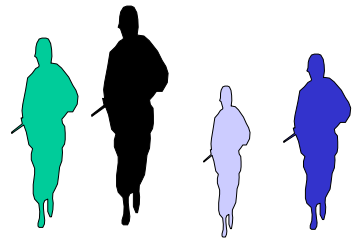
LIQUID PROTECTION

- Many Tests and Evaluation have been conducted to evaluate SPM fabrics; however, ***NOISE AND SIZING REMAIN SIGNIFICANT BARRIERS TO OVERCOME.***

•Problems: Noise and Sizing

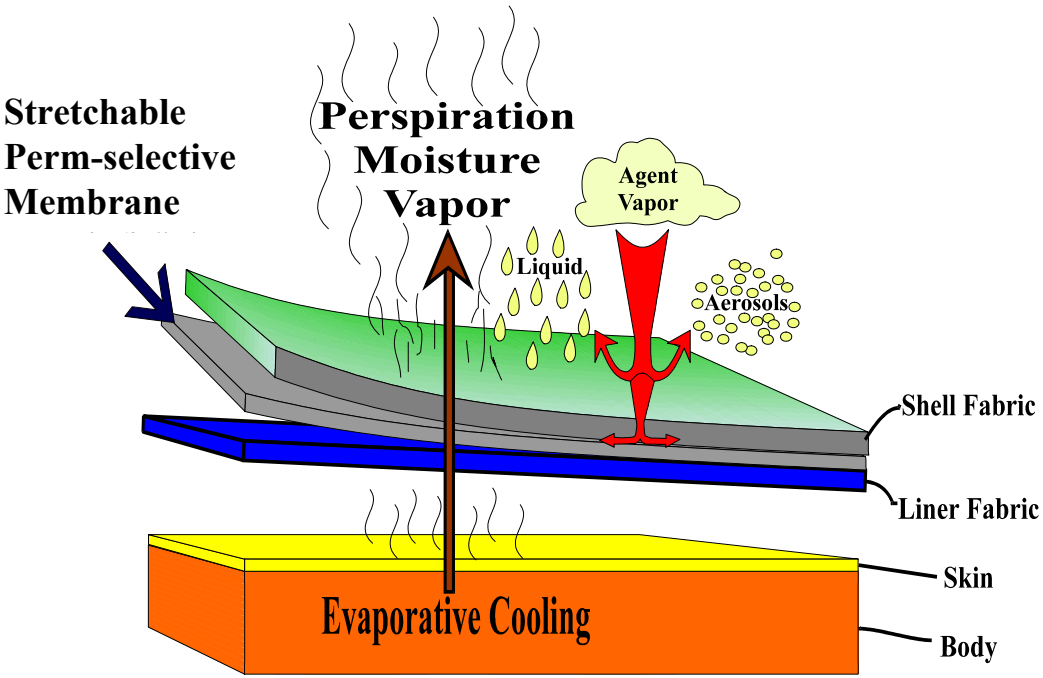
-Many variations of chemical protective clothing

-Many concerns (Costs, Weight, Logistic, Comfort, Mobility, etc.)



-Multiple sizes

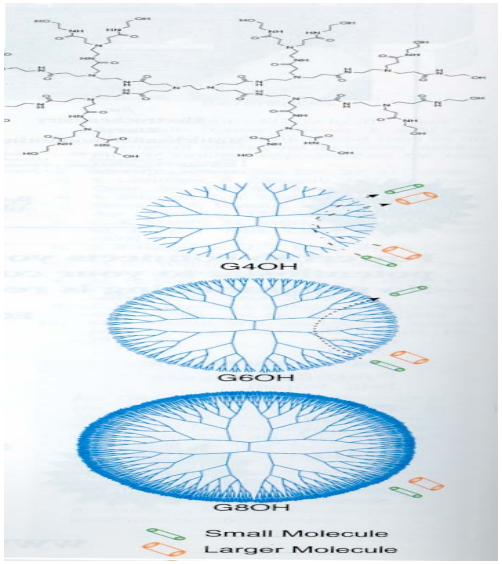
•Material Concept:



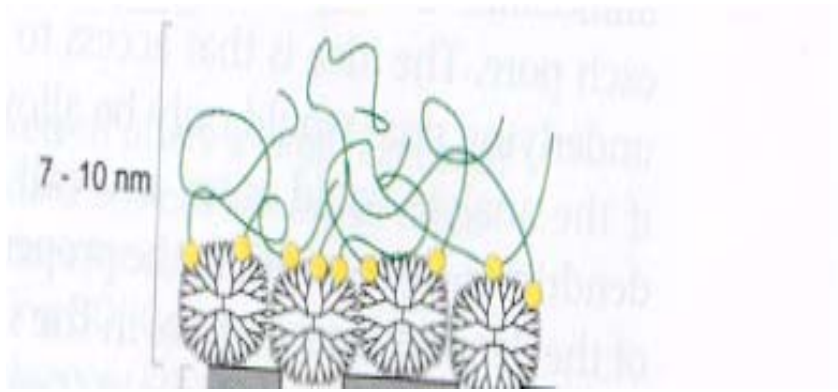
•Capability/Enhancement:

- Reduce/Eliminate multiple size requirement
- Conformable Clothing
- Reduce logistic concerns, and improved operational readiness
- Reduced Noise when "being quiet" is important

Technical Approach --- Prepare dendrimer containing membranes



Blocking efficiency for dendrimers as a function of the density of the peripheral groups.

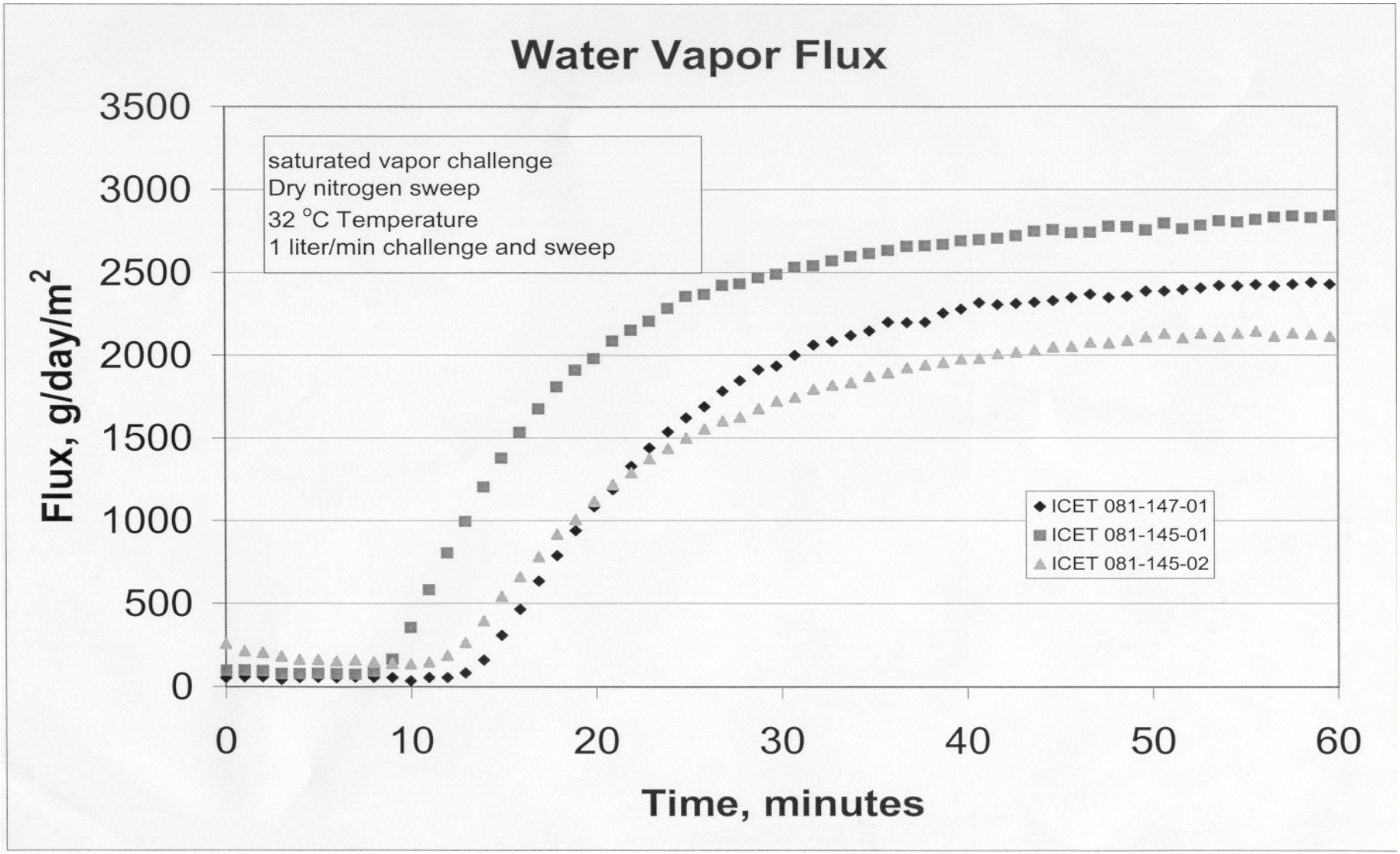


Dendrimer Packing and Cross Linking shows reactive binding polymer molecules for further filtration efficiency

Experimental Results: Dendrimer containing membranes

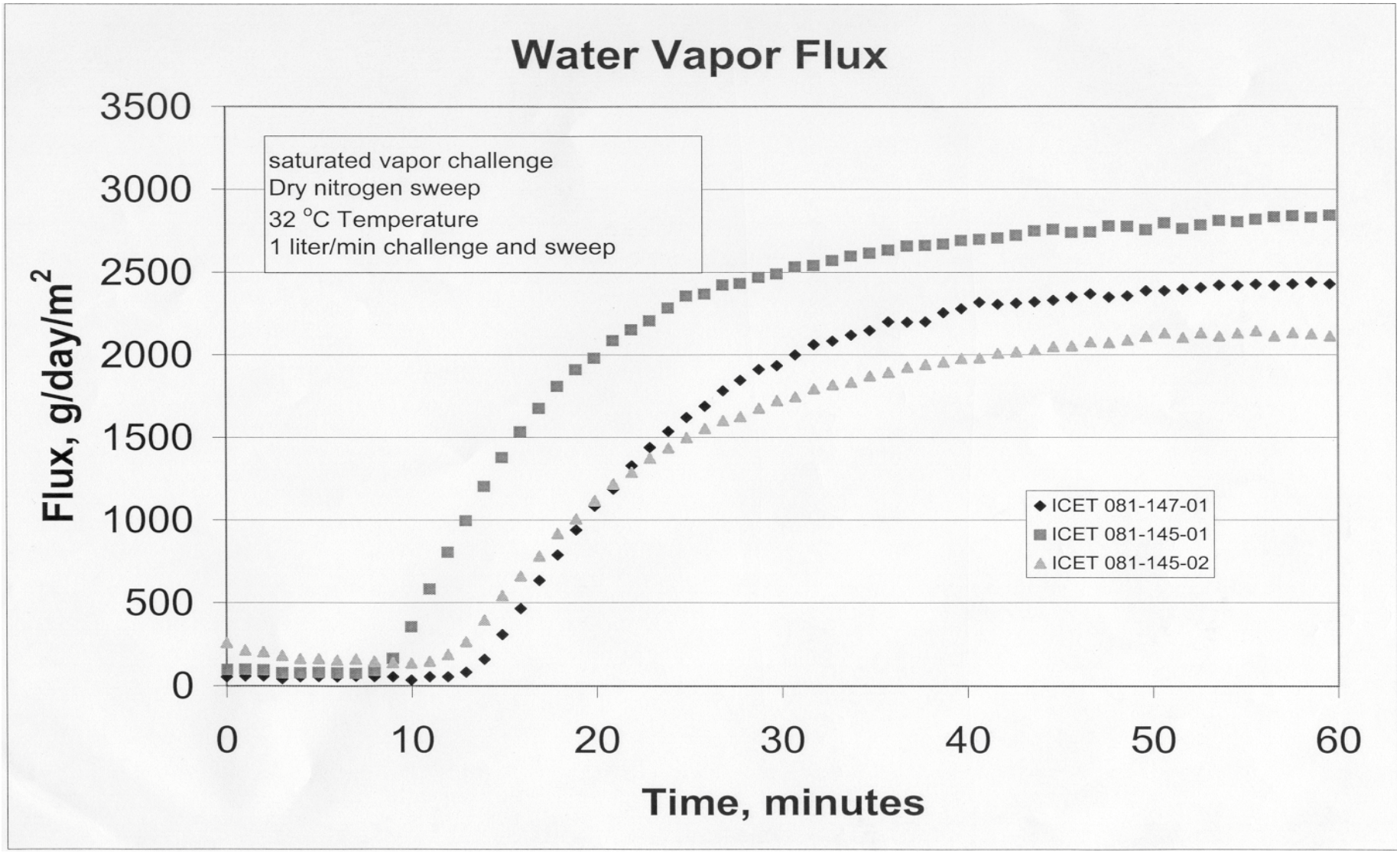
Methods	MVTR (E96-BW) ($g/m^2/day$)	TCE Permeation (E96-BW) ($g/m^2/day$)	Special Notes
Hytrel/Noveon Membrane (Control – 2mil thick)	1,000 – 2,000	10,000 to 20,000	Elastomeric
1. Estane Coated with dendrimer	2,000	10,000	Elastomeric
2. Estane Cross linked dendrimers	19,000	2,000 – 3,000	Elastomeric
3. Incorporate dendrimers in ICET water based proprietary polymer	3,000 WSPC: 2,000-2,800	0 WSPC: 0 after 3 hrs	Elastomeric
4. Self-assembled dendrimer	3,000 WSPC: 2,000-2,500	0 WSPC: 0 after 3 hrs	Not elastomeric
5. PU dispersions mixed with ICET proprietary polymer	To be done	To be done	Elastomeric

Natick's Water/Simulant Permeation Cell (WSPC) Test Results



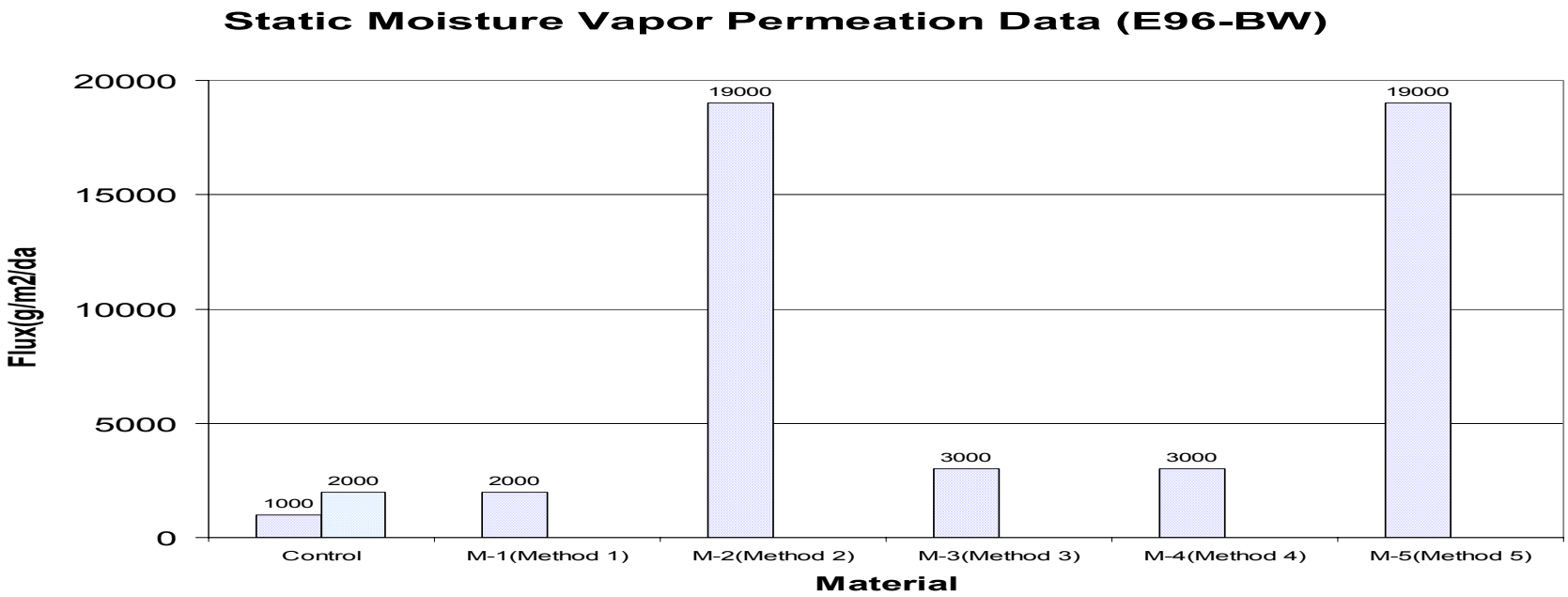
Method 3. Incorporate dendrimers in ICET water based proprietary polymer

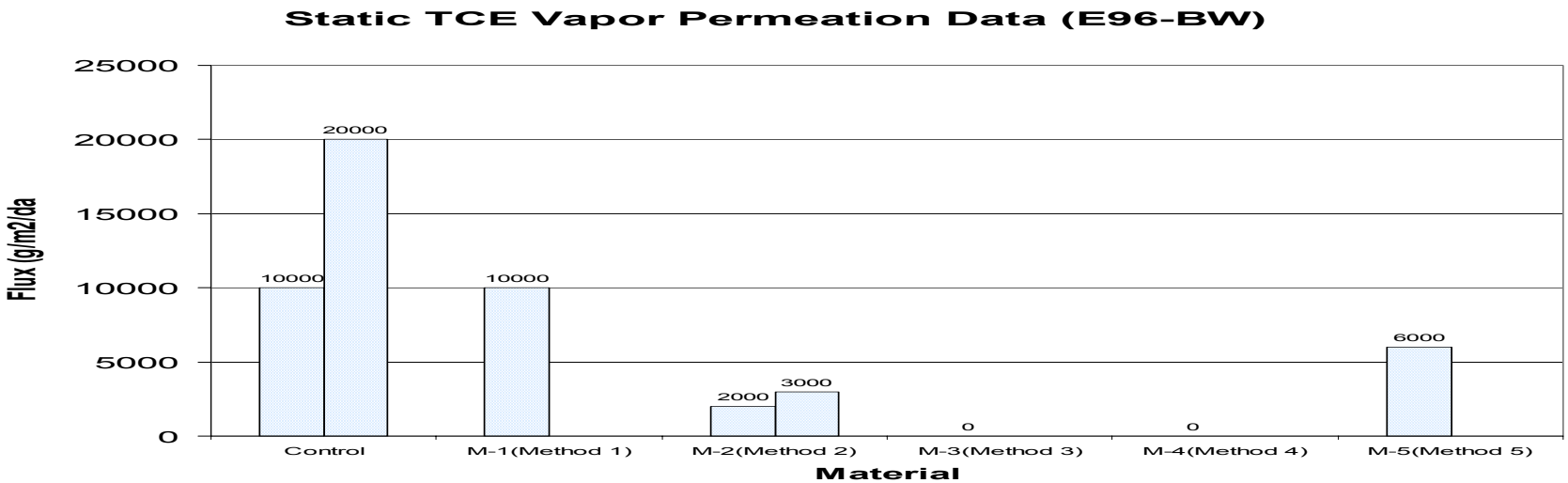
Water/Simulant Permeation Cell (WSPC) Test Results



Method 4. Self-assembled dendrimer

Static Permeation Test Results





Discussions:

Dendrimers are highly hydrophilic and viscous materials. They are very expensive

The direct coating on elastomers through anchoring by surface interactions resulted in coatings that never cured.

Direct incorporation of dendrimers into polymeric dispersions results in tough but flexible membranes.

Using optimal cross-linking of a thin coating appears to over come this difficulty while dramatically improving the moisture vapor permeation and dramatically reducing cost of the eventual commercial products.

This could be a preferred way for optimization for achieving better perm-selectivity.

Conclusions:

- **Extremely thin coating of cross-linked dendrimer were achieved on water vapor Permeable polyurethane elastomers.**
- **Such coatings improve water vapor transport properties significantly while maintaining resistance to organic vapors.**
- **Further optimization work are underway with ICET, Inc. to develop elastomeric SPMs for resistance to both polar and non-polar molecules.**

Recommendations:

- **Follow on work will be on developing dendritic polymers cross-linked coatings where the cross linking agent is flexible PEO segments with reactive end groups on water vapor permeable polymer materials such as TPU latexes modified with ICET fillers and formulations**

Acknowledgments:

Dr. Shantha Sarangapani, Innovative Chemical and Environmental Technologies, Inc. (ICET), Norwood, MA for her dedication in working to Support the US Army Natick Soldier Center's needs to protect our soldiers in Various R&D work since 1985.